11-2-89

WA 2917
11/2/89
79

RECEIVED
NOV - 6 1989
LANCE MUELLER & ASSOC.

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
PROPOSED COLD STORAGE WAREHOUSE
AND FISH PROCESSING FACILITY
PIER 91
SEATTLE, WASHINGTON

FOR

CITYICE COLD STORAGE COMPANY

GeoEngineers

November 2, 1989

Consulting Geotechnical
Engineers and Geologists

CITYICE Cold Storage Company
259 Coleman Building
Seattle, Washington 98104

Attention: Mr. John C. Rosling, President

We are pleased to submit two copies of our "Report, Geotechnical Engineering Services, Proposed Cold Storage Warehouse and Fish Processing Facility, Pier 91, Seattle, Washington, for CITYICE Cold Storage Company". The scope of services for this investigation is described in our confirming agreement dated September 15, 1989. Written authorization to perform the work was provided by you on September 22, 1989. Portions of the results of the investigation have been discussed with Mr. Michael Schaefer of MESA Construction Consultants as our findings were developed.

It is our pleasure to be of service to you on this project. If you have any questions regarding the contents of this report, please contact us.

Yours very truly,

GeoEngineers, Inc.

Jack K. Tuttle
Principal

JEB:JKT:

cc: Mr. Michael E. Schaefer (4 copies)
MESA Construction Consultants
2100 - 124th Ave NE, Ste 113
Bellevue, WA 98005

Mr. Lance Mueller (2 Copies)
Lance Mueller Associates
130 Lakeside, Suite F
Seattle, Washington 98122

File No. 1074-005-B01

GeoEngineers, Inc.
2405 140th Ave. NE, Suite 105
Bellevue, WA 98005
Telephone (206) 746-5200
Fax. (206) 746-5068

GeoEngineers

TABLE OF CONTENTS

List of Figures

APPENDIX

List of Appendix A Figures

REPORT OF GEOTECHNICAL ENGINEERING SERVICES
PROPOSED COLD STORAGE WAREHOUSE AND FISH PROCESSING FACILITY
PIER 91
SEATTLE, WASHINGTON
FOR
CITYICE COLD STORAGE COMPANY

INTRODUCTION

This report presents the results of our geotechnical investigation for a proposed cold storage warehouse and fish processing facility at Pier 91 in Seattle, Washington. The proposed structures will be located west of an existing cold storage warehouse, Building W-390, for which we did a geotechnical engineering study in 1987. A vicinity map and site plan showing the location of the proposed structures are presented in Figure 1.

We understand that the new cold storage warehouse will be a one story structure with plan dimensions of about 300 feet by 283 feet. The building will have a wood frame and will be constructed using concrete tiltup panels. Maximum interior bay spacings will be approximately 28 feet by 48 feet. The floor slab will be constructed at dock height. Design floor loadings will be about 650 pounds per square foot (psf) live load and 170 psf dead load.

We understand that the proposed Fish Processing Facility will be a two story concrete tiltup structure with a steel frame. The first floor will be a dock high concrete slab; the second floor will be a structural slab. The building footprint will be a square approximately 245 feet on each side. Maximum interior bay spacings will be about 30 feet by 30 feet. Design floor loadings will be about 250 psf.

Detailed building design has not yet been completed and estimated column loads are not yet available.

SCOPE

The purpose of our services is to explore subsurface soil and ground water conditions as a basis for developing geotechnical recommendations for site development and project design. Our specific scope of services includes:

1. Exploring subsurface soil and ground water conditions in the proposed building areas by drilling five borings to depths of 59 feet below the existing ground surface.

2. Performing laboratory testing to determine pertinent engineering and physical characteristics of the soils affected by the proposed construction.
3. Providing recommendations for foundation support of the proposed structures including recommendations for shallow-spread footings and pile foundation support.
4. Developing recommendations for support of floor slabs including the possibility of preloading the building areas to induce the major portion of consolidation in the underlying soils in advance of construction.
5. Estimating the magnitude and rates of settlements of the foundations, floor slab, and any fill placed to support the floor slab.
6. Evaluating the probable effects of the proposed construction on any adjacent building foundations and buried utilities.
7. Commenting on any construction problems anticipated from the results of our explorations and studies.

SITE CONDITIONS

SURFACE CONDITIONS

The general area surrounding and including Pier 91 was originally an inlet of Smith Cove. In the early 1900s, the inlet was filled and a few years later the area was purchased by the U.S. Navy for development as a naval pier with associated facilities. In the 1970s, the area was acquired by the Port of Seattle for use as part of their shipping and storage facilities.

Presently, the site of the proposed buildings is a yard and storage area paved with asphalt concrete. Buried utilities including a 12-inch-diameter water line, a 42-inch-diameter storm sewer, and an electrical conduit cross the site. The site surface is generally level with surface variations being less than approximately 2 feet. The surface of the area is presently unoccupied except for new automobiles parked in the northern part and debris containers and shipping pallets in the southern part.

SUBSURFACE CONDITIONS

The subsurface conditions at the site were explored by drilling five borings at the locations shown on Figure 1. Descriptions of the field explorations, boring logs, laboratory testing procedures, and test results are presented in the Appendix.

The subsurface soils disclosed in our explorations generally consist of a surficial layer of sand and gravel fill extending to depths ranging from 8 to 16 feet below the existing ground surface. These soils are underlain by a layer of soft sandy silt containing organic material which extends to depths ranging from 21 to 26 feet where encountered. The silt layer was not encountered in Boring 1. The silt is underlain by granular soils consisting of sand, silty sand, and sandy gravel in a loose to medium dense condition extending to depths ranging from 37 to 54 feet. This layer is underlain by medium stiff to hard silt which extends to the depth explored, 59 feet.

Ground water water observation wells were installed in Borings 1, 4, and 5 to permit observation of water levels after completion of drilling and backfilling of the borings. The ground water levels were observed at a depth of 7½ to 8½ feet below the existing ground surface on October 13, 1989. Ground water levels measured are indicated on the individual boring logs. We expect that the observed water levels will vary with seasonal fluctuations in rainfall and possibly with tidal fluctuations.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

The site is suitable for the proposed improvements. The planned structures can be satisfactorily supported on shallow spread foundations designed and installed as recommended providing steps are taken to reduce postconstruction settlements. A minimum distance of 25 feet should be maintained between the new structures and existing buildings to avoid inducing additional settlement of the existing buildings.

It appears that their is a potential for liquefaction of some of the subsurface soils encountered at the site during the design earthquake. For this reason, piles founded in the underlying medium dense and hard soils may have an advantage over shallow foundation support. Pile foundations will be required for portions of the structures which are highly settlement-sensitive, heavily loaded, or closer than 25 feet to existing buildings.

The underlying soft soils are settlement-sensitive and will consolidate under new loads. A portion of the settlement may be preinduced before construction by preloading prior to site development. In addition, post-construction settlements may be further reduced by excavating loose soils immediately below shallow footings and backfilling with compacted structural fill. We recommend that all footings be underlain by at least two feet of compacted structural fill.

The cold storage facility will require adequate ventilation beneath the floor slab to limit frost buildup and potential heaving. We recommend that a layer of uniformly sized gravel be placed directly beneath the floor slab for this purpose. Adequate venting and/or blower fans should be provided to maintain air flow.

The existing asphalt pavement may be left in place where practical within the building area to take advantage of the stiffness and load distribution provided by the pavement structure. Structural fill may be placed directly over this surface to obtain the design floor elevation.

AFFECT ON UTILITIES AND OTHER FACILITIES

The planned dock height fill and proposed structural loads are of sufficient magnitude to induce areal settlements of the underlying soils. We recommend that the new structures be located no closer than 25 feet from existing buildings to avoid inducing additional settlement of the existing buildings. We recommend that all settlement sensitive utilities crossing the site within 10 feet of the proposed buildings be relocated. Normal precautions and all applicable city, state, and federal regulations should be followed during construction work at the site.

The new structures may be located closer than 25 feet from existing buildings if the building loads are supported on pile foundations.

SITE PREPARATION AND GRADING

General: Site preparation will involve removal of stored automobiles and rerouting or removal of underground utility lines running beneath the building areas. As stated above, the existing asphalt pavement may be left in place where practical. The pavement must be stripped along the building perimeters to allow construction below existing grade.

Ground water seepage zones may be encountered in below grade pits or footing excavations during construction. In our opinion, water entering the excavations from these sources may be handled by installing shallow interceptor ditches or french drains adjacent to or within the excavations, and pumping from sumps, as necessary. In our opinion, the contractor should be responsible for designing and installing the appropriate dewatering system needed to complete the work. This dewatering system should include provisions for disposal of the collected water.

Structural Fill: We understand that the proposed structures will have dock high floors. This will require placement of about 4 feet of fill above existing site grades. Fill placed beneath perimeter footings, or new fill used to achieve design grades within the building area should be placed as structural fill.

Structural fill should be placed in lifts not exceeding 10 inches in loose thickness and each lift should be mechanically compacted to a dense, nonyielding condition. A density of at least 95 percent of the modified Proctor maximum dry density (ASTM D-1557) should be achieved.

Soil placed within two feet of the cold storage floor slab should be placed as structural fill and should consist of uniformly sized gravel to facilitate air flow beneath the slab. The suitability of soils for use as structural fill in other areas will depend primarily on the gradation of the soil and its moisture content when placed. As the amount of fines (material smaller than a U.S. Standard No. 200 mesh sieve) increases, the ability to achieve adequate compaction becomes increasingly sensitive to small changes in moisture content. Soil containing greater than about 5 percent fines is difficult to adequately compact when its water content is about 2 percent above or below the optimum percentage level. If construction is performed during wet weather conditions, we recommend using fill consisting of free-draining, well-graded sand and gravel containing less than 5 percent fines based on the minus 3/4-inch fraction. If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, a somewhat higher (up to 10 to 12 percent) fines content would be satisfactory. It may be feasible to reuse sand soils excavated from below grade excavations on-site as structural fill during periods of extended dry weather, providing that the moisture content of this material is adjusted as necessary for proper compaction.

Soil used for structural fill should be free of organic matter, debris, trash, and cobbles greater than 6 inches in diameter. Particles larger than 3 inches should be excluded from the top 1 foot of the fill. The moisture content of the fill material should be adjusted as necessary for proper compaction.

We recommend that a representative from our firm be present during site preparation and structural fill placement. Our representative will observe the work, evaluate subgrade performance, and perform representative in-place density tests in the fill to determine if the required compaction is being achieved.

PRELOAD AND SURCHARGE FILL

Based on the weight of the dock height fill and the assumed building loads discussed above, we anticipate that settlement of on the order of 3 to 7 inches will occur. We recommend that the building areas be preloaded to preinduce a major portion of this settlement that would otherwise occur when building loads are applied. The purpose of the preload fill is to simulate the anticipated building loads prior to construction. The preload should be placed after the overexcavations and backfilling with structural fill for the footings are complete.

We recommend using a minimum of 7 feet of preload for the cold storage facility and 3 feet of preload for the processing plant based on the assumed building loads. The calculated preload period is 6 to 8 weeks. Our experience indicates that the actual settlement period is usually faster than calculated. The actual period varies from site to site but can be in the range of 1/2 to 3/4 of the calculated period. The actual duration must be determined based on settlement readings.

The required time period can be reduced by placing surcharge fill over the preload fill. The purpose of the surcharge fill is to achieve the calculated building settlements in a shorter time period. The calculated time period for a 5-foot surcharge is four to six weeks. The calculated time period for a 10-foot surcharge is three to five weeks. As previously discussed, the actual period varies from site to site, but is usually less than calculated.

As stated above, we expect up to 7 inches of settlement from the weight of the preload and the dock-high fill. We recommend that before "topping out" the preload, the current settlement amount be subtracted from 7 inches and that the difference be added to compensate for future settlement. That is, we expect the original height of preload to be removed when settlement is completed.

The crest of the preload and surcharge should extend a minimum of 5 feet outside of the building lines except where future expansions are planned. The preload and surcharge should extend a minimum of 25 feet outside of the building area into future expansion areas.

The preload should be monitored to determine the magnitude and rate of settlement. The data will be used to determine whether the consolidation of the underlying soils has slowed sufficiently to allow removal of the preload. We recommend using six settlement plates, one near each corner of the preload and two at the one-third points on the north-south centerline of the structures. The corner plates should be located roughly 40 feet inside of the structure. A detail of a typical plate is shown in Figure 2. The elevations of the plates should be surveyed every other day during filling and twice a week thereafter until the preload is removed. If a rod is bent by construction equipment, it should be straightened and resurveyed as soon as possible. The rod elevations should be referenced to a benchmark located well outside the influence of the site fill, roughly 200 feet from the embankment. The settlement data should be provided to us immediately after the readings are taken so that we may review and comment as appropriate.

FOUNDATION SUPPORT

General: Heavy manufacturing and storage equipment will require pile foundations for support, however specific loading criteria has not yet been developed. Shallow foundations can be used to support the remaining structures after preloading. Support requirements for both cases are discussed below.

Piles: Bases on our analyses, an allowable vertical capacity of 100 tons could be obtained using 16-inch-diameter augercast piling having tip depths 40 feet below the existing ground surface. An allowable vertical capacity of 75 tons could be obtained using 14-inch-diameter augercast piling of the same length. The allowable capacities are based on the strength of the supporting soils for the penetrations indicated and include a factor of safety of about 2.5. The capacities apply to single piles. If piles within groups are spaced at least three pile diameters on center, no reduction for pile group action need be made.

Pile downdrag forces are a consideration if additional surface load such as fill is to be placed within about 15 feet of the piles after or just before pile installation is completed. Pile downdrag forces develop when surrounding compressible soils settle relative to a pile, thus interacting with and adding load to the pile. The effects of downdrag would be increased settlement of the structure and reduced allowable pile capacities. Therefore, any fill should be placed well ahead of pile installation. We should be consulted if this is not the case.

If used, augercast (cast-in-place) concrete piles should be installed using a continuous-flight, hollow-stem auger. As is common practice, the pile grout would be pumped under pressure through the hollow stem as the auger is withdrawn. Reinforcing steel for bending and uplift would be placed in the fresh grout column immediately after withdrawal of the auger.

No direct information regarding the capacity of augercast piles (e.g., driving resistance data) is obtained while this type of pile is being installed. Therefore, it is particularly important that the installation of augercast piles be carefully monitored by a qualified individual working under the direct supervision of a registered engineer.

It should be noted that the recommended pile penetration and allowable capacities presented above are based on assumed uniformity of soil conditions between the explorations. There may be unexpected variations in the depth to and characteristics of the supporting soils across the site. Accordingly, we recommend that pile installation be monitoring by a member of our staff who would observe installation procedures and evaluate the adequacy of individual pile installations.

Shallow Foundations: Shallow spread and strip footings may be used to support the proposed structures after preloading the site. We recommend that the footings be supported on at least 2 feet of structural fill which extends 1-foot beyond all sides of the footing. Foundations supported in this manner may be designed using an allowable bearing pressure of 2500 psf. This value applies to all long-term live and dead loads exclusive of the weight of the footing and any overlying backfill, and may be increased by one-third when considering short-term loads such as wind or seismic influence.

We recommend minimum widths of 24 inches for all isolated footings, and 16 inches for continuous wall footings. All exterior footing elements should be embedded at least 18 inches below the lowest adjacent finished grade. Interior footings for the cold storage facility should be founded below the gravel layer, at least 24 inches below the slab subgrade. Interior footings for the fish processing structure should be founded at least 12 inches below the top of floor slab.

We recommend that any disturbed soils in the footing excavations be removed or, if practical, recompacted prior to concrete placement. All footing excavations should be observed by a representative of our firm to verify adequate bearing surface preparation prior to placing concrete.

Lateral loads may be resisted by friction on the base of footings and floor slab and as passive pressure on the sides of footings. We recommend a coefficient of friction of 0.5 be used to calculate friction between the concrete and structural fill. Passive pressure may be determined using an equivalent fluid weight of 400 pounds per cubic foot. This assumes that structural fill is placed against the sides of the footings and that the top of the fill is confined by either a concrete floor slab or pavement. A safety factor of 1.5 should be applied to these values.

We estimate postconstruction footing settlements of up to 1 inch for both interior and exterior footings prepared as recommended. Differential settlement between adjacent, comparably loaded column footings is not expected to exceed one-half of this value. We recommend that the interior footings be cast integrally with the slab to limit differential settlement of the footing and slab.

FLOOR SLAB SUPPORT

The floor slab can be supported on a dock height fill placed and compacted as previously recommended. If a preload program is not completed, a structural floor slab will be required.

As discussed above, the cold storage facility will require adequate ventilation beneath the floor slab to limit frost buildup and potential heaving. We recommend that a two foot thick layer of uniformly sized gravel be placed directly beneath the floor slab for this purpose. Adequate venting and/or blower fans should be provided to maintain air flow.

The exposed floor subgrade should be proofrolled prior to slab construction. We recommend that a representative of our firm observe the floor subgrade to verify adequate surface preparation prior to placing concrete.

PAVEMENT SUPPORT

The existing pavement appears to be performing adequately and could be left in place wherever possible. We recommend that all new paving areas be underlain by a minimum of 12 inches of structural fill. We recommend a minimum new pavement section for automobile parking areas consist of 4 inches of crushed rock and 2 inches of Class B asphalt concrete overlying the compacted subbase. The crushed rock should conform with the requirements for base course in Section 9-03.9(3) of the State of Washington Department of Transportation Standard Specifications. This base course should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D-1557. In areas subject to frequent truck traffic, the base course and pavement thickness should be increased to 6 and 3 inches, respectively.

LIMITATIONS

We have prepared this report for use by CITYICE Cold Storage and their agents for use in design of a portion of this project. The data and report should be provided to prospective contractors for their bidding or estimating purposes, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

If there are changes in the loads, grades, location, configuration or type of construction for the facilities, the conclusions and recommendations presented may not be applicable. If design changes are made, we request that we be given the opportunity to review our conclusions and recommendations and to provide a written modification or verification.

When the design has been finalized, we recommend that GeoEngineers, Inc. be retained to review the final design and specifications to see that our recommendations have been interpreted and implemented as intended.

The scope of our services does not include services related to construction safety precautions and our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

There are possible variations in subsurface conditions between the explorations and also with time. A contingency for unanticipated conditions should be included in the budget and schedule.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No other conditions, express or implied, should be understood.

\- o O o -

The conclusions and recommendations in this report should be applied in their entirety. We are available to review the final design and specifications to see that our recommendations are properly interpreted. If there are any questions concerning this report or if we can provide additional services, please call.

Respectfully submitted,

GeoEngineers, Inc.

James E. Brigham

James E. Brigham
Project Engineer

Gary W. Henderson

Gary W. Henderson
Principal

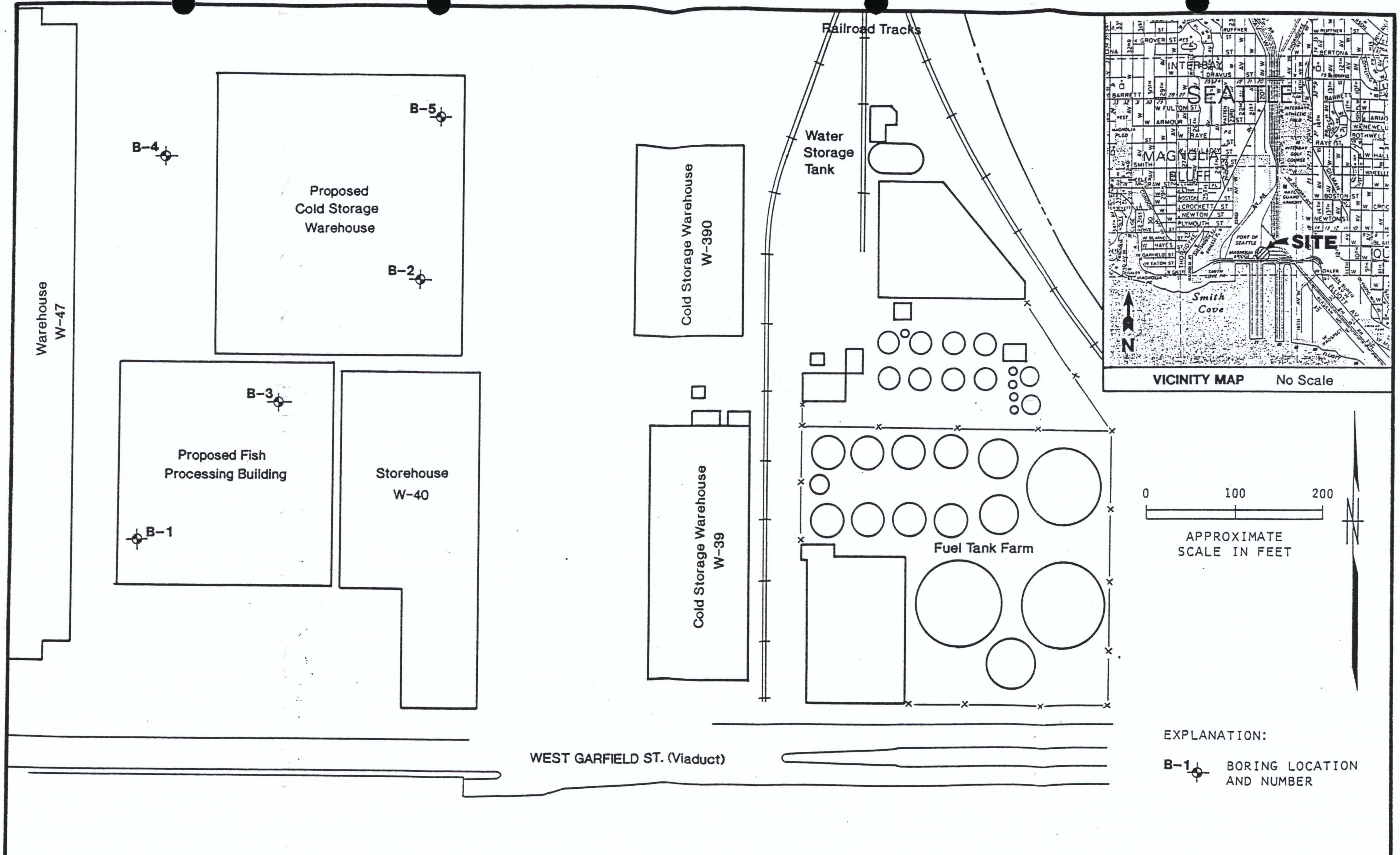
JAMES E. BRIGHAM
STATE OF WASHINGTON
REGISTERED
PROFESSIONAL ENGINEER

JEB:GWH:wd

Attachments

471
0379

1074-05-B01 JEB:KKT 10.25.89

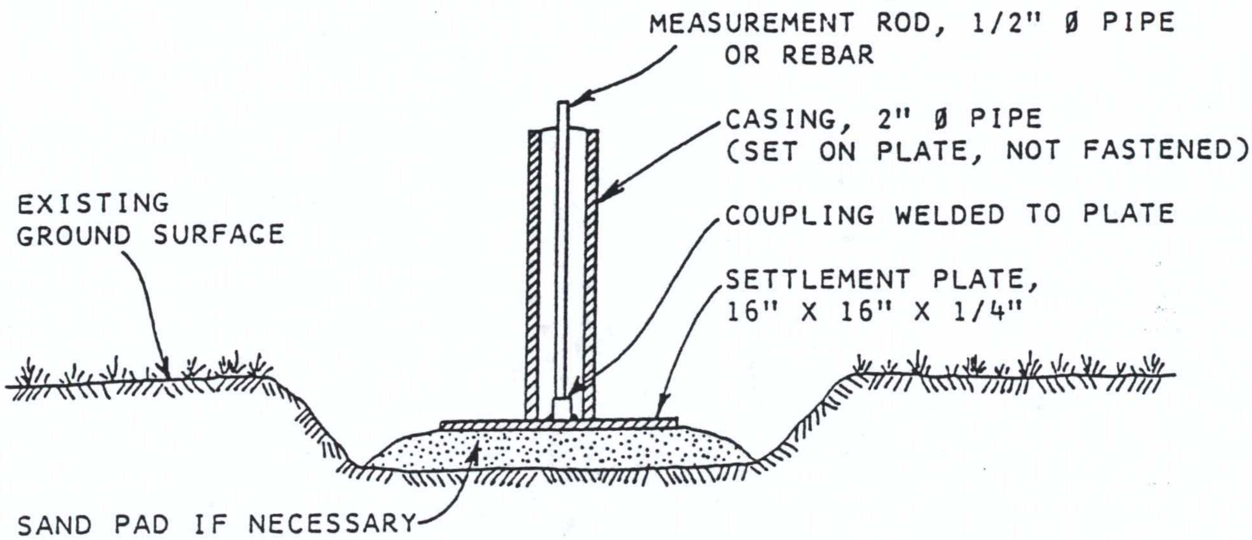


REFERENCE: UNTITLED, UNDATED SITE PLAN PROVIDED BY MESA CONSTRUCTION CONSULTANTS.

GeoEngineers

SITE PLAN

FIGURE 1



(NOT TO SCALE)

NOTES:

1. INSTALL MARKERS ON FIRM GROUND OR ON SAND PADS IF NEEDED FOR STABILITY. TAKE INITIAL READING ON TOP OF ROD AND AT ADJACENT GROUND LEVEL PRIOR TO PLACEMENT OF ANY FILL.

2. FOR EASE IN HANDLING, ROD AND CASING ARE USUALLY INSTALLED IN 5-FOOT SECTIONS. AS FILL PROGRESSES, COUPLINGS ARE USED TO INSTALL ADDITIONAL LENGTHS. CONTINUITY IS MAINTAINED BY READING THE TOP OF THE MEASUREMENT ROD, THEN <u>IMMEDIATELY</u> ADDING THE NEW SECTION AND READING THE TOP OF THE ADDED ROD. BOTH READINGS ARE RECORDED.

3. RECORD THE ELEVATION OF THE TOP OF THE MEASUREMENT ROD IN EACH MARKER AT THE RECOMMENDED TIME INTERVALS. EACH TIME, NOTE THE ELEVATION OF THE ADJACENT FILL SURFACE.

4. READ THE MARKER TO THE NEAREST 0.01 FOOT, OR 0.005 FOOT IF POSSIBLE. NOTE THE FILL ELEVATION TO THE NEAREST 0.1 FOOT.

5. THE ELEVATIONS SHOULD BE REFERENCED TO A TEMPORARY BENCHMARK LOCATED ON STABLE GROUND AT LEAST 100 FEET FROM THE EMBANKMENT.

GeoEngineers

SETTLEMENT PLATE DETAIL

FIGURE 2

APPENDIX A

APPENDIX

SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

SUBSURFACE EXPLORATIONS

The subsurface conditions at the project site were explored by drilling five test borings at the locations shown in Figure 1.

The borings were drilled between September 5 and 8, 1989 to a depth of 59 feet below existing grade, and were advanced using a truck-mounted, continuous-flight, hollow-stem auger drill rig. Representative samples were obtained at frequent intervals using a 3-inch outside diameter split-barrel sampler. The sampler was driven into the soil using a 300-pound hammer free-falling 30 inches. The number of blows required to drive the last 12 inches, or other indicated distance, is recorded on the boring logs.

The borings were continuously logged in the field by a field geologist from our firm. Soils were classified in general accordance with the system described in Figure A-1.

A key to the boring log symbols is presented in Figure A-2. The logs of the borings are presented in Figures A-3 through A-12. The locations of the borings were established using drawings provided by MESA Construction Consultants. The exploration logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. They also indicate the depths at which these soils or their characteristics change, although the change might actually be gradual. If the change occurred between samples, it was interpreted.

LABORATORY TESTING

All soil samples were brought to our laboratory for further examination. Selected samples were tested to determine their moisture content, dry density, and consolidation characteristics.

The results of the moisture content and dry density tests are presented on the exploration logs.

Consolidation tests were performed on two representative samples of the compressible soil strata to determine the compressibility characteristics of the site soils. Results are presented in Figures A-13 and A-14.

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS MORE THAN 50% PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-83.
2. Soil classification using laboratory tests is based on ASTM D2487-83.
3. Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water

Wet - Visible free water or saturated, usually soil is obtained from below water table

GeoEngineers

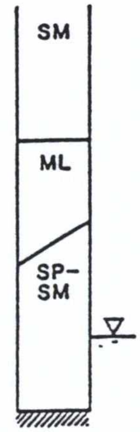
SOIL CLASSIFICATION SYSTEM

FIGURE A-1

LABORATORY TESTS:

AL	Atterberg limits
CP	Compaction
CS	Consolidation
DS	Direct shear
GS	Grain-size analysis
HA	Hydrometer analysis
K	Permeability
M	Moisture content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfined compression
CA	Chemical Analysis

SOIL GRAPH:



Soil Group Symbol (See Note 1)

Distinct contact between Soil Strata

Gradual Change between Soil Strata

Water Level

Bottom of Boring

BLOW-COUNT/SAMPLE DATA:

Blows required to drive Dames & Moore sampler 12 inches or other indicated distances using 300 pound hammer falling 30 inches.

"P" indicates sampler pushed with weight of hammer or hydraulics of drill rig.

22	Location of relatively undisturbed sample
12	Location of disturbed sample
P	Location of sampling attempt with no recovery
10	Location of sample attempt using Standard Penetration Test procedures
40	Location of relatively undisturbed sample using 140 pound hammer falling 30 inches.

NOTES:

1. Soil classification system is summarized in Figure A-1.
2. The reader must refer to the discussion in the report text as well as the exploration logs for a proper understanding of subsurface conditions.

GEI 86-88

GeoEngineers

KEY TO BORING LOG SYMBOLS

FIGURE A-2

TEST DATA

BORING B-1

Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples
			29	■
MD	22	100.6	11	■
			7	■
			11	■
MD	13	123.5	5	■
			18	■
			13	⊠
			21	■

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Group Symbol	DESCRIPTION
	Surface Elevation:
	3-inches asphalt concrete pavement over 3-inches gravel base
SP	Brown fine to coarse sand with gravel (medium dense, moist to wet) (fill)
SP	Gray fine to coarse sand with gravel and shell fragments (loose to medium dense, wet)

Note: See Figure A-2 for explanation of symbols

Geo Engineers

Log of Boring

Figure A-3

1074-005-B01 JEB:CDO 11/2/89

BORING B-1 (continuted)

TEST DATA

Depth in Feet	Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples	Group Symbol	DESCRIPTION
43				12	□		
45.5						ML	Gray silt (stiff, moist)
48	MD	36	87.8	12	■		
53				12	■		
58				16	■		
59							Boring completed at 59.0 feet on 9/5/89 Piezometer installed to 59.0 feet Groundwater level measured at 8.4 feet on 10/13/89

DEPTH IN FEET: 40, 45, 50, 55, 60, 65, 70, 75, 80

Note: See Figure A-2 for explanation of symbols

GeoEngineers

Log of Boring

Figure A-4

1074-005-B01 JEB:CDO 11/2/89

BORING B-2

TEST DATA

Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples
MD	29	88.3	6	■
			19	■
MD	32	91.1	1	■
MD	29	94.4	2	■
			4	■
			3	■
			3	⊠
MD	16	119.7	6	■

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Group Symbol	DESCRIPTION
	Surface Elevation:
	3-inches asphalt concrete over 3-inches gravel base
SM	Gray silty fine to medium sand (loose, moist) (fill)
SP	Gray fine to coarse sand with silt (medium dense, wet) (fill)
ML	Gray silt with a trace of fine sand (very soft, wet)
SP	Gray fine to coarse sand with silt and occasional gravel (very loose to loose, wet)
GP	Black fine gravel with fine to coarse sand (very loose, wet)
SM	Gray silty fine to medium sand with shell fragments (loose, wet)

Note: See Figure A-2 for explanation of symbols

GeoEngineers

Log of Boring

Figure A-5

JEB:CDO 11/2/89

1074-005-B01

BORING B-2
(continued)

TEST DATA

Depth (feet)	Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples	Group Symbol	DESCRIPTION
40						SP	Gray fine to coarse sand with silt and shell fragments (medium dense, wet)
				21	■		
				25	□		
				22	■		
						ML	Gray silt with a trace of fine sand (hard, moist)
	MD	7	134.4	63	■		
							Boring completed at 59.0 feet on 9/7/89

DEPTH IN FEET: 40, 45, 50, 55, 60, 65, 70, 75, 80

Note: See Figure A-2 for explanation of symbols

GeoEngineers

Log of Boring

Figure A- 6

1074-005-B01 JEB:CDO 11/2/89

BORING B-3

TEST DATA

Depth (ft)	Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples
3				47	■
8	MD	7	134.4	9	■
13				2	■
18	MD	34	88.8	4	■
23				6	■
28	MD	18	119.3	7	■
33				9	■
38				44	■

DESCRIPTION

Surface Elevation:

Group Symbol	Description
GP	2-inches asphalt concrete over 4-inches gravel base Brown and gray fine to coarse sandy gravel (dense to very dense, moist) (fill)
SP	Brown fine to coarse sand with gravel (loose, wet) (fill)
SP	Gray fine to medium sand with a trace of silt and shell and wood fragments (very loose, wet)
ML	Gray silt with fine sand and occasional wood and shell fragments (soft, wet)
SM	Gray silty fine to medium sand with wood and shell fragments (loose, wet)
SP	Gray fine to coarse gravel with silt, occasional gravel, and shell fragments (medium dense to dense, wet)

DEPTH IN FEET: 0 to 40

Note: See Figure A-2 for explanation of symbols

1074-005-B01 JEB:CDO 11/2/89

GeoEngineers

Log of Boring

Figure A-7

BORING B-3 (continuted)

TEST DATA

Depth in Feet	Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples	Group Symbol	Description
40							
				18	■		
						ML	Gray silt (hard, moist)
45							
				47	■		
50							
				53	■		
	MD	18	114.2				
55							
				32	■		
							Boring completed at 59.0 feet on 9/8/89
60							
65							
70							
75							
80							

Note: See Figure A-2 for explanation of symbols

JEB:CDO 11/2/89

1074-005-B01

GeoEngineers

Log of Boring

Figure A-8

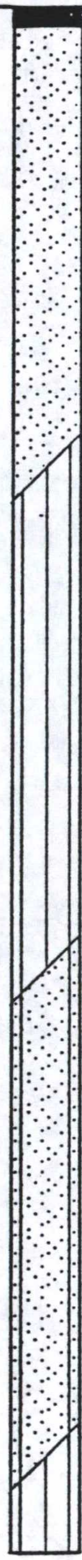
BORING B-4

TEST DATA

Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples
MD	2	125.7	17	■
			14	■
MD CS	36	87.8	3	■
MD	36	86.6	2	■
MD	30	95.9	2	■
			3	■
MD	19	113.4	10	■
			8	■

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Group Symbol



DESCRIPTION

Surface Elevation:

3-inches asphalt concrete over 3-inches gravel base

SP — Brown fine to coarse sand with gravel and shell fragments (medium dense, moist to wet) (fill)

ML — Gray silt with a trace of fine sand (very soft to soft, wet)

SM — Gray silty fine to coarse sand with gravel and shell fragments (loose to medium dense, wet)

ML — Gray silt with gravel and shell fragments (medium stiff to hard, wet)

Note: See Figure A-2 for explanation of symbols

GeoEngineers

Log of Boring

Figure A-9

1074-005-B01 JEB:CDO 11/2/89

BORING B-4 (continued)

TEST DATA

Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples	Group Symbol	DESCRIPTION
					ML	Gray silt with gravel and shell fragments (medium stiff to hard, wet)
			47	■		
MD	28	96.6	17	■		
			26	■		
MD	31	94.7	15	■		

DEPTH IN FEET: 40, 45, 50, 55, 60, 65, 70, 75, 80

Boring completed at 59.0 feet on 9/6/89
Piezometer installed to 59.0 feet
Ground water level measured at 7.8 feet on 10/13/89

Note: See Figure A-2 for explanation of symbols

GeoEngineers

Log of Boring

Figure A-10

1074-005-B01 JEB:CDO 11/2/89

BORING B-5

TEST DATA

Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples
			18	■
			6	■
MD CS	49	75.5	4	■
			4	■
MD	32	92.1	2	■
			16	■
MD	12	129.9	12	■
			6	■

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

Group Symbol	DESCRIPTION Surface Elevation:
	3-inches asphalt concrete over 3-inches gravel base
SP	Brown fine to coarse sand with occasional gravel (medium dense, moist) (fill)
SP - SM	Gray fine to medium sand with silt (loose, wet) (fill)
ML	Gray silt with fine sand (soft, wet)
SP	Gray fine to medium sand with silt (loose, wet)
ML	Gray silt with fine sand (very soft to soft, wet)
SM	Gray silty fine to coarse sand with gravel, shell and wood fragments (loose to medium dense, wet)

Note: See Figure A-2 for explanation of symbols

1074-005-B01 : JEB:CDO 11/2/89

GeoEngineers

Log of Boring

Figure A-11

TEST DATA

BORING B-5 (continued)

Depth in Feet	Lab Tests	Moisture Content %	Dry Density (pcf)	Blow-Count	Samples	Group Symbol	Description
40						SP	Gray fine to coarse sand with gravel, and shell fragments (medium dense to dense, wet)
43				45	■		
48				23	■		
53				24	■		
57						ML	Gray silt (stiff, moist)
58				16	■		
59	MD	29	95.4				

Boring completed at 59.0 feet on 9/6/89
Piezometer installed to 59.0 feet
Ground water level measured at 7.5 feet on 10/13/89

Note: See Figure A-2 for explanation of symbols

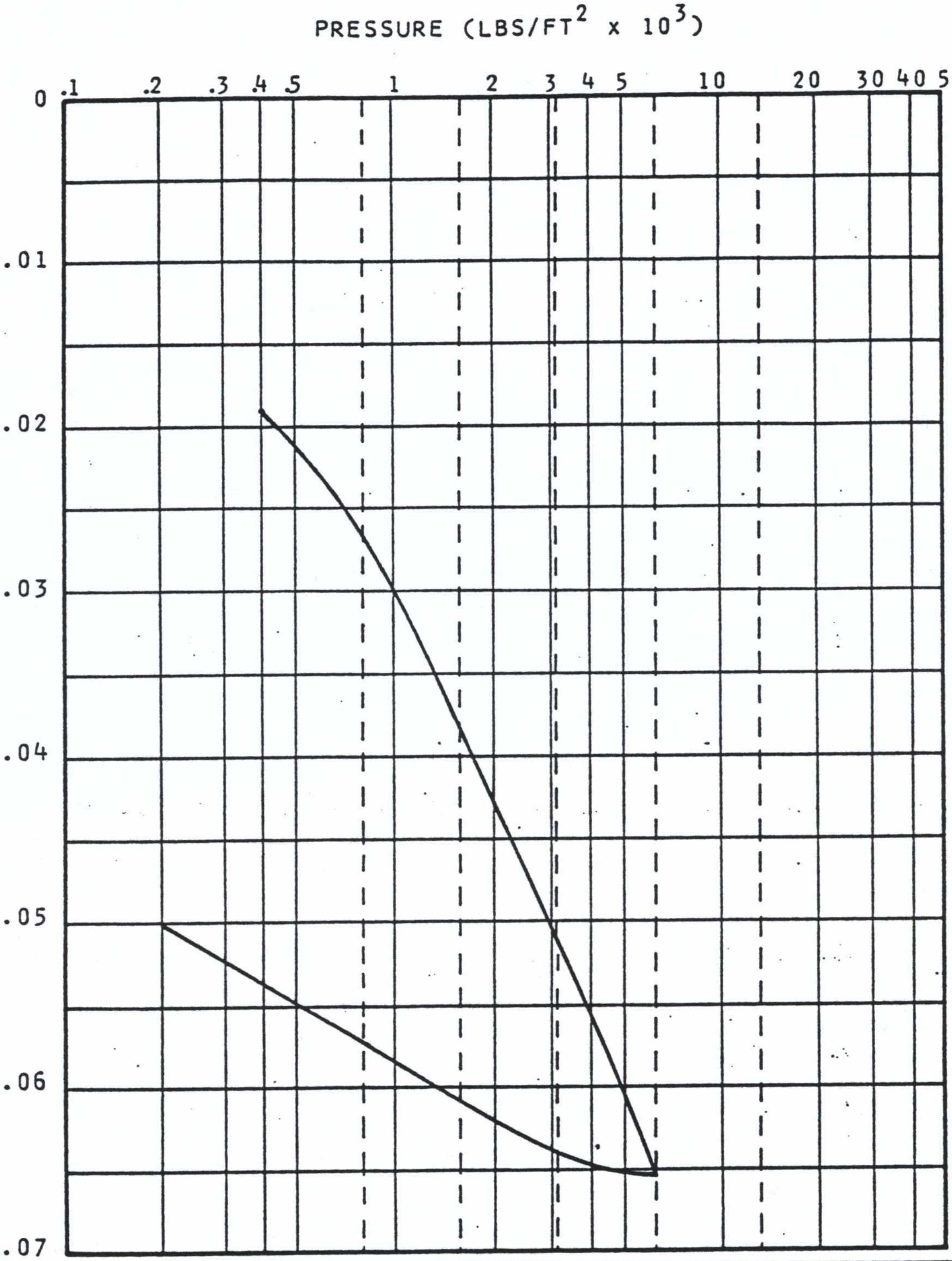
GeoEngineers

Log of Boring

Figure A-12

1074-005-B01 :JEB:CDO 11/2/89

1074-005-B01 JEB:KKT 10/25/89



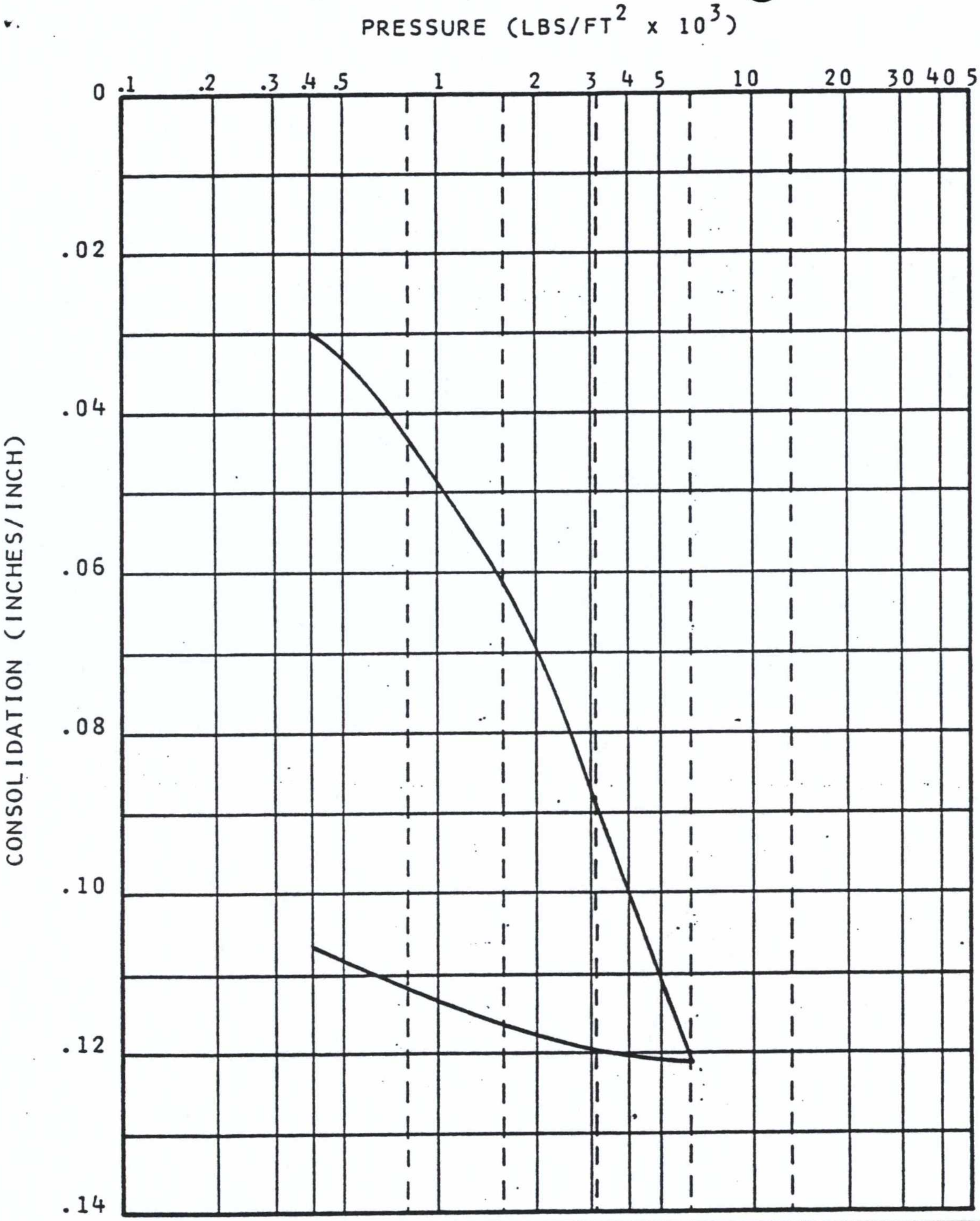
KEY	BORING NUMBER	SAMPLE DEPTH (FT)	SOIL CLASSIFICATION	MOISTURE CONTENT	DRY DENSITY (LBS/FT³)
————	B-4	13	GRAY SANDY SILT WITH OCCASIONAL ORGANIC MATERIAL (ML)	36%	87.8

Geo Engineers

CONSOLIDATION TEST RESULTS

FIGURE A-13

1074-005-B01 JEB:KKT 10/25/89



KEY	BORING NUMBER	SAMPLE DEPTH (FT)	SOIL CLASSIFICATION	MOISTURE CONTENT	DRY DENSITY (LBS/FT^3)
———	B-5	13'	GRAY SILT WITH FINE SAND (ML)	49%	75.5

GeoEngineers

CONSOLIDATION TEST RESULTS

FIGURE A-14